

Chapter 6 - Appendix S.

A Cultural Framework for Natural Hazard Resilience Guide: proactive strategies from the Waipi'o Valley Community – Background and Proposed Future Plans

The need for Community-based disaster management:

Many communities in Hawai'i have established systems and capacities to govern and manage their resources and are currently making major decisions conventionally assumed by government. In fact, Hawai'i has a strong heritage of place-based management, ahupua'a management that should be considered an asset for risk reduction planning. Overlooking the role and capacity of communities to plan and organize mitigation and recovery projects and programs denies a major asset for disaster management in Hawai'i.

The United States Government Accountability Office (GAO) has identified the need for the Federal Emergency Management Agency (FEMA) to develop a framework to link pre- and post-disaster planning at the local level. The United Nations Centre for Regional Development Disaster Management Planning Office, Hyogo Framework of Action (HFA), at the World Conference on Disaster Reduction (WCDR) in Kobe, Japan also identifies the need to support community-scale resilience planning:

Strategic Goal 12 (b) *The development and strengthening of institutions, mechanisms and capacities at all levels, in particular at the community level, that can systematically contribute to building resilience to hazards.*

Priorities for Action 1: *Ensure that disaster risk reduction is a national and a local priority with a strong institutional basis for implementation.*

The Role of Culture and Community in Resilience Planning in Hawai'i:

A Cultural Framework for Natural Hazard Resilience Guide: proactive strategies from the Waipi'o Valley Community (the guide) advocates for a strategic resilience planning process to enable the Waipi'o Valley community, and other communities statewide, to derive and run their own resilience plans. More than simply inspiring an interest in community resilience planning, the guide focuses on decreasing the discrepancy between our ideals, our plans, and actions through practical, preventative strategies that merely adapt the established systems and re-organize assets already sitting in our laps.

The guide focuses on resilience, defined as applying concepts and practices of traditional, place-based management to the disaster recovery or hazard mitigation process, can be achieved through active dialogue and task-specific partnerships between government representatives and community leaders.

Intent of the plan and guide:

This work shows how culture may serve as a foundation for community-based projects, providing more than a set of values and knowledge source, but also a

system for place-, resource-, and community-based management and governance. The guide shares how the Waipi'o Valley uses their ahupua'a system, as foundation for value-based planning and the physical ahupua'a boundary as an organizational planning unit. Systems, values, and practices of culture may not only be considered resilience assets, but may in themselves be strengthened as a result of the risk itself. Cultural integrity is reinforced through the opportunity to use the cultural planning and governance framework of ahupua'a, as an interface between community and government, showing how rights, roles, and approaches typically assumed by formal government agencies and NGOs can be shared with community organizations.

Specifically, the guide provides a step-by-step framework to help the community develop a phased work plan, scope of work, and best management practices (BMPs) grounded in culture. The community experience, provides an example of what a community-scale resilience plan looks like and how state and county planning tools and policies may be adapted for community-scale projects.

Shows that the process between prevention and recovery should be seamless. In fact, preventative measures should inform the recovery measures. The community may apply the lessons they have learned during the ongoing (preventative) mitigation program to develop more carefully thought-out measures that can be easily applied in an emergency mode, during the recovery process. For instance, they may guide the recovery work by showing what actions and conditions may de-stabilize the land, damage the water table, habitat, or the ancient irrigation system. Oral history & recent accounts of recovery work, conducted in emergency mode when the ground was wet & soft, has lead to unintended damage.

One of the products of the work is a community-derived resilience indices, reflective of the unique social, cultural, and environmental systems of Hawaii. The to development of integrated natural & cultural resources planning process & standardized tools is one of the major objectives of the Hawaii Coastal Zone Management program of Office of Planning, Ocean Resource and Management Plan (ORMP (Perspective 3, Promoting Collaboration and Stewardship). The guide hopes to provide a process that can help agencies understand how they can help communities enable their plans and sustain their programs.

Audience:

The guide speaks to active community members, resource providers, and regulators who are making land and resource use decisions and are interested in integrating risk reduction measures. The guide provides a process for formulating measures in a way that protects cultural and natural resources, and traditional livelihoods and management systems.

Framework and scope:

The framework of the resilience guide follows similar criteria laid out in the National Mitigation Strategy. It defines common risk reduction objectives among the State and County Hazard Mitigation Plans and the CZM Ocean Resource Management Program. It also provides a framework for shared governance, using a traditional management approach for community self-governance. The report is focused on partnerships between the community, resource providers, and resource regulators. The guide is centered on performance measures, called resilience elements, which are linked with objectives and indicators (mentioned above).

Partners:

Implementation of the stream management program will require the community partnerships with large land owners and government agencies to create clarify rights, responsibilities, and address issues of potential liability associated with the mitigation work. A potential solution is for the community to establish a long-term lease with a private industry, a bonded contractor, who can implement the work supervised by community leaders. It will also require that the community develop a “sponsorship” relationship with a government agency to help them enable the plan. One which integrates traditional and contemporary governance and management approaches. The community-initiated resilience program is working with government resource regulators and providers to articulate how they can “build capacity for community participation in natural and cultural resource management” (Perspective 3, Promoting Collaboration and Stewardship).

The Waipi'o Valley Community Circle, DURP, and USDA Natural Resource Conservation Service spent a year to develop a flood-focused, risk management plan.

Partners at this planning stage are centered on the permitting process, including agencies such as: Army Corp of Engineers, Department of Health, DLNR Hawai'i County Planning Office and Public Works. USDA Natural Resource and Conservation Service (NRCS) and Mauna Kea Soil and Conservation Districts are acting as the sponsor agencies to lead the way through a “packaging permit” process, which will involve inter-agency and inter-governmental review. Hawai'i State and County Civil Defense, USDA RCND, and CZM are working to assist the community. Hawai'i Tourism Authority is also a partner, starting a fund for two community Information Officers which serves the dual role of educating visitors about the cultural significance of the valley and the natural hazard risk they are exposed to when entering the valley. The community is currently working with State Civil Defense to apply for the HGMP and PDM.

The link between recovery and prevention:

The GAO, identifies the current retro-active approach of national disaster management as a pitfall that must be addressed. In fact, acting on this shortcoming is a major tasks assigned to FEMA in the Post-Katrina Emergency Management Reform Act of 2006 (Post-Katrina Reform Act).

Implementation of the stream management program will require the community partnerships with large land owners and government agencies to create a shared governance system. One which integrates traditional and contemporary governance and management approaches. The community-initiated resilience program is working with government resource regulators and providers to articulate how they can “build capacity for community participation in natural and cultural resource management” (Perspective 3, Promoting Collaboration and Stewardship).

Historically, the Waipi’o Valley community has been working within a system that is set up to work retroactively rather than proactively. NRCS, County of Hawai’i, and Army Corp of Engineers have all helped rebuild the community after floods, tsunamis and landslides. Emergency Watershed Protection (EWP) assistance was denied by the SCS State Conservationist due to the repeating nature of the storm damage. The denial letter also stated that “the flooding problems are caused by a continuous deposition of rocks and gravel in the streambed minimizing its carrying capacity rather than by a single event.” (NRCS, Waipi’o Valley Stream Management Plan, 2006). The community must act on the lessons they’ve learned about the detrimental role of mitigation, explain how the inability to conduct a routine mitigation program has increased their vulnerability, and work with the regulatory agencies to implement their plans for increasing resilience. The community will now be asking for government support, but in a different way. Instead of asking for support to recover from another disaster, they will ask for assistance in taking action to prevent or reduce the disaster from occurring. According to the GAO, preventative work pays off: “Hazard mitigation activities have been found to be a sound investment with every \$1 FEMA provides communities for National Institute of Building Sciences mitigation activities, resulting in an average of \$4 in future benefits” (GAO).

These plans are outlined in an excerpt from the Waipi’o Stream Management Plan below. The community is currently acquiring permits and funds to start a pilot project, which is part of a five phased program. The work will be conducted seasonally, moving from the stream mouth (makai) to the back of the watershed (mauka). The community has decided to use their limited resources and energy to address their vulnerability and risk at the mitigation stage. However they are approaching mitigation in a way that blurs the line between preventative and recovery work.

The catalyst for the community-initiated resilience program:

Flooding is the most widespread and destructive of these, resulting in billions of dollars in property losses each year. This fact has proved true for residents in Waipi’o Valley. Many farmers have had their entire farm destroyed, forcing them to abandon farming in the valley. Any time a flood damages taro that has been planted, it creates a major set-back. This requires the farmer to invest in more huli, re-build components of the farming infrastructure, and wait two and a half

years (depending on the extent of damage) for the soils to replenish and newly planted crop to mature for harvesting.

As we speak, many farmers in the valley stand to lose their entire life savings if the next high waters flood their farms. This has forced many farmers of the past to abandon this culturally-connected way of life. However, this does not have to be the case. The community knows what they need to do to reduce this risk. Why do farmers have to wait and watch their farms wash away?

Traditional management in Waipio Valley:

The waterhead leader system is an example of how traditional systems are kept alive. The water distribution system is a critical component of ahupua'a management, or waterhead leader system (WHL). This system is both physical and social. Both components of the system have been passed on from the ancestors of the valley and used today. The system is centered on established waterheads, or physical places where the water is diverted from the natural river and guided into the auwai, man-made irrigation channels that feed the wetland taro fields (lo'i). In this sense, the Waipi'o Valley community is a hydrological society, in which their management and governance systems are based directly on the natural system. This heritage stems from ancestors of the land that realized the importance of fresh water in a fragile island environment. They developed a management system based on the behavior of water, tracking the movement of water. In every aspect, the water management system for livelihood is based on the natural hydrological systems.

Integrating hazard mitigation, cultural, and environmental preservation and restoration:

The objective, to integrate hazard mitigation with natural and cultural conservation is consistent with the ORMP 5-Year Management Goals and Strategic Actions, (Perspective 1, Connecting Land and Sea), to "protect beaches, wetlands, and coastal communities from... coastal hazards", and (Perspective 2, Preserving our Ocean Heritage) the objective to "improve the health of coastal and ocean resources for sustainable traditional, subsistence, recreational, and commercial use," while also applying integrated and place-based approaches to the management of natural and cultural resources, by developing planning process and standardized tools (Perspective 3, Promoting Collaboration and Stewardship).

GAO highlights the necessity to: "protect, restore, and enhance the natural protective features such as floodplains, wetlands, beaches, dunes, and natural drainage ways can also help mitigate a community's vulnerability to damage from storms and associated flooding." The Waipi'o Valley project focuses on preserving and restoring their floodplains and wetlands, which serve as natural buffers, and their coastal wetlands and dunes, which absorb and protect from

storm surge. The work is multi-faceted mitigation actions designed to reinforce self-sufficiency and the integrity of the cultural and ecological systems.

Background:

The community lies entirely within a flood plain and Special Management Area (SMA). It is also one of the most significant areas for perpetuating the Hawaiian culture and agricultural lifestyle. The community is connected to this natural hazard-prone area because their livelihood and heritage is steeped in farming the wetland plant, kalo. The Waipi'o Valley Community on the Island of Hawai'i has thrived in the fertile riverbeds of the valley for centuries while learning how to co-exist with waters that both feed and destroy their community. However, as traditional practices began to intersect modern activities in Waipi'o Valley, the need for a stream management plan emerged.

This guide expands on that work to focus on multi-hazards that threaten the community, while focusing on the impact to of kalo farming and the capacities of the traditional Waterhead Leader System to reduce their risk. Based on their risk-knowledge, the community has decided to focus first on the most threatening natural hazards, which are flooding compounded with storm surge and rain-induced landslides. Experience has taught the community that they have little control over large floods which spread stormwaters from wall to wall of the valley. However, they have learned that certain activities allow them to have some control during smaller-scale floods, which are the focus for their project.

The community started the planning process by conducting a hazard, risk, & vulnerability assessment. They also derived their own resilience measures, along with protocols developed by the cultural council, to assure that each mitigation action protects cultural, coastal, and watershed resources while enriching the livelihood of kalo farming. The community's program meets the State of Hawai'i Hazard Mitigation Plan (2007), Goal 3: *Ensure the protection of the State's natural, built, historical, and cultural assets*, Objective 1: *Identify and map assets, including sensitive environmental features and cultural sites and use areas*. The methodology and maps are detailed in the guidebook. Their program is based on Goal 3, Objective 3: Incorporate indigenous knowledge into hazard mitigation planning, and Objective 6: minimize environmental degradation and ensure habitat recovery. The assessment stage of the community's program meets Goal 2, Develop and implement the Statewide Hazard Mitigation Plan based on a comprehensive, multi-hazard risk and vulnerability assessment, objective 7: to incorporate natural hazard elements (including risk and vulnerability, hazard maps, hazard mitigation best practices and standards).

The following are excerpts taken from the Waipi'o Valley Stream Management Plan (2006). This plan was developed through an inclusive planning process, facilitated successfully by the non-profit, Friends of the Future, for over a decade. Partners involved in developing the plan include USDA Natural Resource Conservation Service and UH Department of Urban and Regional Planning. The

following focus on the natural hazard assessment and the proposed mitigation actions:

Chapter 4: The Need for the Management Plan

One major concern of the Waipi'o community is flooding in the valley, and the effects of that flooding on crops, structures and residents of the valley. Invasive trees worsen this concern; for instance, many Java Plum trees that grow near the stream are often toppled during floods, blocking the stream channel and thereby diverting flows that are often difficult and expensive to rectify. Gravel bars also develop into islands, constricting, and sometimes redirecting the flow of the stream, causing streambank erosion and dangerous flood conditions. Also, when the sand bar "closes" the river mouth, water backs up and damage from flooding during high rainfall events is often worse. Dumping of water from the Upper Hamakua Ditch during the wet season is thought to increase flood flows as well.

Several comments from participants were made regarding the flood situation in Waipi'o.

A Corps study of a flood diversion channel through the taro growing area to the ocean was requested by one of the community members. A similar study was apparently conducted in the 1970s, but no follow up actions were taken. Lolly Silva will discuss the request with the Corps Civil Works branch. Alternatives to a flood diversion channel were also discussed.

One topic that most of the community agreed on was the need to keep the muliwai (estuary) and river mouth open to the ocean. Many thought that there is a need to clean the river and open the river mouth, at least annually. There was also discussion that a caretaker, like that from plantation times, may be needed to clean and manage the Lower Hamakua Ditch and Upper Hamakua Ditch intakes and result in less flooding in the Valley.

Waipio has an intricate network of auwais (or taro ditches) that transport water out of the stream and back into the stream at various points in the stream channel. Members of the Waipio community wanted the plan to address auwai management, incorporating the traditional waterhead system of management. Water distribution and auwai system capture are important components of this management. Many community members believe that taro production in the valley needs to be expanded, using auwai maps from 1800's and before. They believe this is culturally important and also that auwais could be used to help control flood flows.

Many concerns were expressed, regarding water flows at the Kunaka split. Some residents believe water quality is poor in Kunaka stream due to a low rate of water flow, and the low water flow in Kunaka limits the land that can be put into taro production. Additionally, less water in Kunaka means more water in the main channel and possibly more severe damage during storm events.

Another important issue that concerns the community is erosion of the stream banks.

Erosional areas near Kunaka split and above the Kawashima farm were identified, during outreach sessions as important areas to address.

Minimizing the environmental impacts of stream maintenance is important to many Waipi'o community members. Low populations of native species and high populations of invasive, alien species both in the stream and adjacent to the stream are concerns.

Currently, the Bishop Museum leads area schools in conducting monitoring of stream life and water quality. The community would like to be able to use this resource better perhaps for permit monitoring or helping to understand the impacts of stream maintenance activities.

The Waipi'o community also voiced concerns about the cost of stream maintenance and requested help with identifying funding sources. They also thought agency over-regulation was a problem and requested help reducing the paperwork necessary to attain permits and guidance on what permits needed to be obtained.

Other Issues

A number of other issues may impact stream management in Waipi'o Valley but are not fully addressed in this plan. These issues include access, historical and cultural resources, tourism, agriculture and natural resources (DURP 2001). The stream management plan is only one piece of the puzzle that will hopefully lead to a more comprehensive watershed management plan with full community support. Consensus on how to address the following issues will require further discussions between the community members of Waipi'o.

First, many historical and cultural sites of the valley are known, and the valley is still rich with sites that have not yet been uncovered or examined. There is agreement that preservation needs to take place, but exactly how is yet to be determined. These sites continue to be deemed sacred and storied places and are part of the native Hawaiians cultural heritage.

Waipi'o Valley has been historically and is currently an ideal place for wet taro cultivation and perpetuation of Hawaiian culture. Soil types and vegetation patterns for the valley explain its agricultural productivity potential. There is an untapped market for taro that can guarantee the successful continuation and expansion of taro production in the valley. The wellness of cultural and commercial taro farming depends on the ability of farmers to undertake regular stream management with full financial, technical, and permitting support of the pertinent agencies and other parties.

A variety of access issues occur because it is not clear (or not adequately enforced) which pathways are for the public and which pathways belong exclusively to the landowners and lessees. Related to these issues of access is the topic of tourism. The level of tourism that should occur in the valley is an issue of much contention in the Valley. This issue is also interrelated with many other areas of the discussion in the Valley, including management, respect, and responsibility and equity in terms of sharing revenues, costs and impacts.

Finally, the stream management plan only peripherally addresses water quality and wildlife issues. A more comprehensive plan that looks at on-farm and residential management is desirable. A few of the items to be addressed would include wastewater management, pesticide and nutrient management as well as wildlife habitat management.

Invasive species in particular are a growing concern. These threats range from a plant community dominated by invasive species to the threats to crops from species such as the apple snail to nuisances such as the coqui frog.

Chapter 2: Background

The drainage area from which raindrops run on the ground surface toward the Waipi'o Valley mouth at the ocean is defined as the Waipi'o Watershed. As such, the Waipi'o Watershed can be subdivided into Wailoa Subwatershed which includes the Wailoa River and its tributaries, Waimā, Ko'iawe, Alakahi, and Kawainui Streams, and Hi'ilawe Subwatershed which includes the streams that flow into Hi'ilawe Valley, at Hi'ilawe, Hakalaoa, and Ipu'u Falls. The Hi'ilawe Subwatershed terminates where Hi'ilawe Stream enters Wailoa River.

Droughts:

Flow in the Wailoa River during periods of extended drought remains fairly consistent compared to other streams in the vicinity. The spring sources of the river in the Kawainui, Alakahi, Ko'iawe, and Waimā tributaries connect to large elevated water reservoirs confined in the Kohala basalt by the extensive dike matrix. Hi'ilawe Stream and other streams along the Hamakua coast are reduced to dry streambeds during such periods. The minimum discharge recorded by USGS during their five year record keeping period was approximately 22 MGD with the Lower Hamakua Ditch diversion in operation.

Tsunamis:

Tidal waves occurred in 1819 and 1837 (Lennon 1954:11). In 1946 a 55-foot tidal wave inundated the Valley and destroyed many homes and taro patches. (Salmoiraghi & Yoshinaga, 1974). The tidal wave proved to be extremely devastating. The wave rolled inland more than 3000 feet. Many of the farmers who lived in the Valley left Waipi'o and found residence in the uplands of Hamakua. After the tidal wave, less than two dozen people remained.

Flooding:

Waipi'o Valley's history is marked by periodic flooding caused by overflowing

rivers resulting from heavy rains. Between 1916 and 1950 flooding occurred almost bi-annually; flood damage to crops was reported in 1918, 1932, 1936, 1938, 1941, 1942, 1958 and 1963.

Damaging floods occurred in all months of the year except July and August. (Lennox 1954; Honolulu Advertiser, June 24, 1956). A major flood occurred in 1979 and many taro farms were destroyed. The destruction required a huge cooperative repair effort in which County, State and federal agencies, private businesses and Valley residents participated.

During November 14 to 19, 1979, Waipi'o Valley was badly damaged by flooding from rainfall that totaled 36 inches during the storm period and over 14 inches in a 24-hour period. Two miles of channel were filled with sediment, all 20 homes in the valley were damaged by floodwater. Approximately 110 acres of taro were destroyed by scour or deposition.

Changes in the stream system rendered thirty auwai sections inoperable. The damage repair consisted mainly of pushing the deposited material to the sides to create channel capacity and the use of the local material to rebuild destroyed sections of levee. NRCS (formerly SCS) repair work for the 1979 storm cost was noted as \$105,000 or \$250,000 in 2005 dollars.

NRCS repair work for the 1986 storm cost \$95,000 (or \$170,000 in 2005 dollars). A November 21, 1987 storm damaged Waipi'o Valley prompting another request for emergency assistance. Nearly one-half mile of Hi'ilawe Stream channel was filled

with sediment six feet deep. One home on the upstream side of the Hi'ilawe Stream crossing was completely destroyed. SCS again denied the request for post-flood assistance. The damaged locations were the same locations as damaged in the earlier storms. EWP assistance was denied by the SCS State Conservationist due to the repeating nature of the storm damage. The denial letter also stated that "the flooding problems are caused by a continuous deposition of rocks and gravel in the streambed minimizing its carrying capacity rather than by a single event."

In February 2002 a flood through Waipi'o caused considerable damage primarily by felling large trees in a number of areas which redirected the stream into lo'i and other developed farmland. Considerable movement of gravel and cobbles in the upper reach occurred. According to accounts a flood of this magnitude had not occurred since the late 1980s. This flood opened the beach dune at the river mouth and lowered the stream water surface elevation by as much as five feet in the lower reach of the stream. The opening of the river mouth relieved many of the problems being experienced by farmers in the lower reach, including saturation of lowlying areas, frequent flooding during minor rainfall events, and inefficient auwai operation. NRCS engaged in an emergency effort with the County of Hawai'i to remove trees from the stream channel in the upper and

middle reaches.

In March 2004 a flood event severely damaged the upper reach, felling numerous trees along the flood corridor perimeter and breaching the levees on both sides of the corridor.

The flood relocated the channel over 100 feet laterally in some areas and mobilized tremendous quantities of coarse sediment. Well-vegetated gravel bars that had been identified for removal in 2001 remained stable with new channels forming around them.

NRCS again engaged in an emergency program with the County of Hawai'i, removing fallen trees, reestablishing channel capacity and repairing banks along some reaches.

Generalized treatments for the Waipi'o streams were developed that balanced the need for preventing flooding and sediment damage to the taro lo'i and other structures with the desire to accommodate stream processes and maintain high water quality and biological stream value. Site-specific discussions for the identified problem areas are also included below to indicate the range of treatments that should be considered at the problem site. Treatments for road crossings, auwai systems, and streambank protection are also discussed. These treatments are presented for further discussion and refinement by the Waipi'o community. It is hoped that an inclusive decision-making process can be used by the community to develop details for the preferred treatments. These, then, will be adapted into designs that will reflect community acceptance, funding level and risk.

Actual installation of treatments at the sites should be according to engineering designs that have been reviewed by the stakeholder agencies and community. The designs will normally include topographic mapping, dimensions, standards and specifications for materials and work, and approval by permitting and regulatory agencies. Installation work will require funding agreements, project staking, approval of materials and contractors, project inspections, best management practices, and monitoring.

Stream Corridor Establishment:

The primary alternative involves the establishment of a stream corridor which incorporates the understanding of stream geomorphology and hydraulic processes.

The intention is to maintain a wide active channel area within which most stream functions, including transport and deposition of sediment can occur. During floods when the water surface rises above the banks, an adequate floodplain to contain frequently occurring floods can be developed using setback levees along the perimeter. Small trees and shrubs vegetating the floodplain can slow velocities in the floodplain and keep the main channel the preferred pathway for the floodwater. An important consideration is the transport of sediment through the corridor without long term positive deposition in the corridor which will result

in continued aggradations within the corridor but not outside. The corridor is not intended to completely exclude flood water from the area outside of the corridor but is intended to restrict the damaging bedload flows to within the channels. The perimeter levees should be constructed to allow occasional overtopping to spread the floodwater and to distribute fine sediment. The levees should also be designed to resist collapse the case of overtopping.

Auwai:

Lo'i that are repeatedly damaged by floods should be identified and considered for relocation. In this way, a widened flood corridor, within which dynamic movement of the stream can be accommodated, can be established. This alternative is already being successfully implemented to some degree in an area above the Toledo farm and on the Kohala side of the Mock Chew farm. The corridor edges can be established with setback levees and dense vegetation. Another alternative to levees are screens such as fences, fallen trees or gabions to allow water to flow through but trap the bedload in the flood corridor.

Nearly all of the land that is needed to establish a stream corridor is owned by Bishop Museum. However, land within the corridor is leased to taro farmers. A reassignment of parcels may be needed if some of the existing taro lo'i is converted to the stream corridor. A strategy would be not to repair taro lo'i located in the corridor damaged in future floods.

Bedload Management:

Many of the stream-related problems facing the Waipi'o Community are the result of the high bedload discharge of the Wailoa River. Bedload is the rocky material that the stream transports by rolling along the stream bed. It is the gravel, cobbles and boulders that normally make up the stream bed and is moved downstream during high flow events. The bedload in Wailoa River is generally deposited by size as the river approaches the ocean. As the valley slope and the stream gradient flatten once the stream reaches the bottomland of the valley, the boulders and larger cobbles are deposited at the upper end of the taro growing area. Smaller bedload sizes are deposited further down the river. Stormflows can remobilize these deposits.

The lower area of the Waipi'o watershed where the lo'i and dwellings are located is the

depositional zone of the Wailoa River. Where the upstream zones are the source of the

stream-borne sediments or serve to transport the sediment without appreciable net loss or accretion, the depositional zone is the sink for most of the coarse sediment transported by the river. Fine sediments, and some coarse sediments during stormflows, are carried by the stream into the ocean. The broad and flat Waipi'o bottomland was developed through deposition by an efficient sediment-dispersing stream system over tens of thousands of years.

In a natural state, it is expected that the stream in the upper reach of the study area, where it emerges from confinement by the valley walls, would continually adjust as coarse sediment is deposited due to the decrease in valley slope. The frequent changes in stream deposition and meander in this area near the Rathbun and Toledo farms is an indication of the dynamic processes at this location. A solution to the problem may be providing a location where the sediment can be deposited by the stream and removed from the stream corridor easily. The larger stones deposited in this area can be used in the lower reaches for stream stabilization.

Typically, bedload is managed by deposition in a sediment or debris basin. Such basins slow streamflow to cause deposition of the bedload mobilized by the stream. The basins have a dedicated storage volume to retain the deposited bedload. As the storage volume is filled the effectiveness of the basin will decline. Removal of the accumulated sediment when the basin is filled is critical for the operation of the basin. Sediment basins normally have an outlet structure that is capable of safely passing through severe storm discharges without movement or erosion. Such outlets are generally significant structures to handle the hydraulic forces generated by flood flows. The sediment basin should be designed to avoid “sediment starvation” of lower stream reaches to prevent an erosion problem due to an upset of the sediment transport budget. The coarse sediment trapped in an upstream basin can be used in projects to stabilize downstream reaches.

Gravel Bar Treatment:

The deposition of sediment within the stream channel causes formation of gravel bars and islands. These formations can move the active channel laterally and direct stream flows into the banks, both of which result in bank erosion and flood threats to farmland and other developed areas. In Waipi‘o, these gravel bars include larger sediment sizes like cobbles and boulders. Problem gravel bars are usually formed during significant storm events with the hydraulic power to fully mobilize the streambed. Once formed, however, less intense storm events are unable to move the larger stones that lock the bar in place. In time, the establishment of shrubs and trees on the gravel bar increases the stability of the bar or island. Deposition of fine sediment on the bar in subsequent storms further improves growing conditions for vegetation, improving the permanence of the island or bar.

A method to remove or reduce the durability of gravel bars is to remove the surface vegetation and to remove the sediment above the stream water surface level. This method is described in the State Stream Channel Alteration Permit Application prepared for the WTFA in 2001.

Islands in midstream – Sta 4000 to Sta 6000

Islands have formed in the middle of the stream and have been stabilized by

mature

vegetation. These islands appear to advance braiding of the stream channel. Mechanized stream maintenance normally removed islands from the stream. These islands may be due to accretion processes that cause stream meander as some of the islands serve to increase the stream thalweg. Streamflow is being deflected toward the streambanks and stream velocities are increased due to the narrowing of the stream flow area. While average stream velocities are relatively slow in this reach due to the flat gradient, during high flow events average velocities in the range of 3 fps can be expected. The strongest stream velocities are often directed to impinge on the banks. The alluvial streambanks are being eroded at their base resulting in undercutting and vertical banks when banks collapse. During high flow events, the vegetation growing on the island also serves to slow flows across the island and to deflect high flow velocities to the stream banks.

Several alternative treatments to remove or alter the islands can be considered. Removal of the island and its vegetation using heavy machinery can be considered if the bank erosion is proceeding at such a rapid rate that immediate relief is necessary. A State Stream Channel Alteration permit will be required for any movement of material within the banks. A federal CWA Section 404 permit and Section 401 Water Quality Certification may not be required if the work does not place any material in the stream. However, written correspondence with the Corps of Engineers Regulatory Branch should be conducted describing the work to be accomplished, including methods, dimensions and timing. The State Department of Health will likely request a pollution control plan be filed as a condition of the Stream Channel Alteration Permit. Notification of the County Planning Department and Public Works Department is recommended.

The removal of vegetation from the island can make the sediments more susceptible to erosion and removal by the stream. Removal of vegetation will also increase stream velocities across the island during high flows and may reduce erosive forces against the streambanks. No permits may be required if the bank or bottom materials are not disturbed and the trimmed vegetation is removed from the stream channel. The use of herbicides should be thoroughly considered and used only in conformance with labeled uses to avoid liability.

A river training structure known as a stream barb can be used to reduce the stream forces away from the banks and toward the island to intensify erosion of the island. While the structure will be very similar in form to a manowai, a State Stream Channel Alteration Permit and a federal 404 permit will likely be needed. Once the erosive stream forces that are responsible for the streambank erosion are managed, treatment of the bank to stabilize the steep or undercut bank can be considered. Typically, NRCS recommends shaping the bank to a 2:1 slope and vegetating the graded bank. Stability is improved by protecting the toe of the bank with rock. Permits will likely be required for this work.

Bank erosion above Kawashima:

The stream appears highly unstable in this reach, evidenced by abrupt slope changes from the upstream section, a history of bank erosion that has felled large trees on the bank, and recent stream avulsions. The stream appears to be trying to braid. Midstream deposition has created islands, which have deflected flows toward the banks and is creating a wider, braided stream corridor. Avulsion of the stream to the west is feared. The marshland toward the Muliwai Fishpond appears to lower in elevation than the stream and if flows were to breach the western bank the stream could be captured by the marshland to the west. The area to the west includes major cultural sites that might be disturbed if the stream was to flow in that direction.

The manowai and auwai for the Kawashima waterhead have been affected by the changes in stream elevation and erosion of the western bank. The apparent drop in the stream elevation has required the intake location to be moved upstream to maintain the hydraulic relationship between the intake and the auwai system. Bank recession has eliminated the land between stream and the auwai. The auwai is now separated from the stream by a stacked ridge of rock and plastic sheeting. Maintenance effort for the current configuration is very high.

Some actions can be taken. Removal of the tall trees that are on the bank. These trees are at risk of being toppled into the river if the bank is eroded. The eroded banks on the western side can be repaired and broadened to reduce the chance of avulsion of the stream to the west. The rebuilt bank should be vegetated and protected against further erosion. Riprap bank protection should be considered here due to the significant effect of bank failure. Stream flow should be directed away from this bank. Upstream stream barbs can be considered to redirect streamflow into the middle of the stream and to dissipate stream energy.

A reconstruction of the manowai and auwai system needs to account for the hydraulic gradient needed by the Kawashima farm for irrigation of their taro lo'i. The flattening of the stream gradient below this reach makes auwai management at this location very difficult. The manowai should be moved to a location that can consistently provide supply. A conveyance solution could be the use of pipe in some of the parts of the auwai. An issue with the use of pipe is sedimentation within the pipe.

Road crossing:

The main ford crossing of Wailoa River on the dirt road which extends west from the end of the County Road is used by most farmers and residents on the western side of the River in addition to use by tour operators, both on horseback and vehicles. The major problem is the changing river bottom, especially after high flows, which sometimes becomes too deep for vehicular crossing. Generally the rocks that form the ford are washed downstream. There appears

to be an increased stream gradient downstream of the ford.

The preferred configuration is a broad, flat ford. Stones are often moved around by residents to restore the ford. The stones that hold the ford are generally the locally available sizes. Larger stones than those normally transported by streamflow to the location will be more stable at the location.

A recommendation will be to imbed several large stones on the lower side to stabilize the general elevation of the streambed. At the downstream cross section, average stream velocities exceed 7 fps with flow depths of 4 feet when flows break out of the streambanks at 1,000 cfs. It is assumed that flood flows can exceed 10 fps at the downstream of the crossing with depths of 6 feet. The large stone sizes should be about 3 feet in diameter and should be imbedded to one-half of its diameter as measured on the downstream side of the rock. Rock that is 16" to 20" should be placed around the large anchor rocks to prevent scour around the large rocks.

Other alternatives may include structural improvements such as a concrete ford. Due to the large amount of bedload passing the location low flow culverts beneath the ford are not recommended.

Kunaka Split:

The Kūnaka split is an inlet for the auwai system serving the lo'i in the interior of the large bend in the Wailoa River. For some farmers, the Kūnaka auwai, also known as the

Kūnaka River on the WTFA map can also serve as a major waterway during high flow periods to reduce flow and flood problems in the main channel. Other farmers in the

Kūnaka area resist the idea of having more floodwater due to the threat of increased flood damage. One complaint is that insufficient irrigation water is diverted and transported in the Kūnaka auwais for the lo'i in the lower areas.

Continuing discussions and agreement among the Kūnaka area farmers with input from other Waipi'o farmers with input from other Waipi'o community members and farmers, regarding the amount of water in the Kūnaka Stream are needed. In order to resolve this issue a more intensive survey of the taro irrigation need and flood vulnerability should be conducted. NRCS can help to develop scenarios during low flow and high flow periods.

Two elements that need to be addressed in this agreement are defining the intake to the Kūnaka Stream and removing sediment from interior waterways.

Meander Sections:

This reach between 10,000 feet to 13,000 feet from the river mouth is a dynamic transport reach. As a result of storm flows in recent years, the stream configuration in this reach has undergone significant alteration in both plan and elevation. The 2002 storm raised or lowered the stream by three to four feet at

several of the resurveyed cross sections through erosion or deposition. The March 2004 storm moved the main channel of the river nearly 100 feet laterally in some places.

From the 1960s to 1990s, the stream was apparently bulldozed back into place following storms with significant levees on both sides of the stream developed in the bulldozing process. The recent storms breached the levees on both sides of the stream, providing an indication of the power of the streamflow at this location. The hydraulic analysis for this reach indicates average channel stream velocities approaching 12 fps for a 1,000 cfs flow.

The maintenance of a wide flood corridor in this area is essential as the valley slope and coarse sediment volume and large size makes this area the most dynamic with a potential to avulse and rapidly change channel configuration. A well-defined and open stream corridor with vegetated floodplains flanking both sides of the stream is recommended.

Large trees, capable of toppling into the stream, should be removed from the stream banks. Any levees along the perimeter of the flood corridor should be designed to resist collapse when overtopped by floodwater. The levees should be short enough to allow floodwaters to overtop the structure during significant floods to redistribute fine sediment and relieve pressure on the flood corridor.

Bank Protection:

Erosion of streambanks is the predominant erosion problem in the area. However, it does not appear to be a major problem in the study area. The two most prevalent causes of bank erosion in Waipi'o seem to be 1) the movement of the stream laterally, as in a meander, and 2) streamflow being directed against a bank by obstructions such as fallen trees or piled up coarse sediment. A stream avulsion can be considered a rapid bank erosion event when the failure of a section of bank causes the stream to rush into a new channel. Streambank protection can consist of vegetative plantings, soil bioengineering or structural systems.

Two basic categories of bank protection exist. The first type reduces the erosive force of the water against the streambank by reducing localized stream velocities next to the bank, preventing impingement of flow directly into the banks, reducing eddying and/or reducing tractive stresses. The second type of protection increases the resistance of the bank to erosion by flattening the bank to reduce effect of gravitational forces, improving cohesiveness or matrix of bank soils and/or covering erodible soils with a nonerodable layer.

If stream velocities are generally mild, shaping the bank to flatten it and planting it in appropriate vegetation that will protect the soil surface by reducing flow velocities on the soil surface and have a rooting system that can resist the tractive forces on the exposed plant parts. In deeper channel sections, the tractive stresses on the lower part of the bank can be significantly higher than

that near the surface due to the increased weight of the water column. Stabilization of the bank toe is important. Often rock riprap will be placed at the toe to provide stability to an earthen bank.

As stream velocities increase, structural elements, in addition to vegetation, must be considered in the streambank protection system to maintain stability. Some methods to consider include the use of geotextile fabrics to wrap lifts, rock riprap revetment, log or rootwad revetment, and gabions. The modification of the velocity gradient of the stream to reduce high streamflow directed against the bank can be achieved with stream barbs and jetties that protrude into the stream flow. The effect of the streamflow over and around the barbs and jetties is intended to deflect the high velocity currents back to the middle of the stream. A good reference is NRCS, Engineering Field Handbook, Chapter 16 Stream and Shoreline Protection.

Flood levees:

Flood levees provide additional flow capacity to the stream by elevating the water level in the stream above the bank. Levees can be set on the bank or setback away from the bank. Setback levees are preferable to bankside levees as the depth of out of bank flow is reduced and some dynamic adjustment of the stream banks is allowed. Levees are designed to be resistant to erosion and overtopping. Engineering standards for Dike Practice Code 356 will apply.

Set back levees will create a floodplain that can be managed. It is important to keep the floodplain a less preferable flow path by keeping roughness higher than the stream channel. Deflections toward the bank should be avoided and flow streams should be directed back toward the channel. Large trees should not be planted on the levees to prevent the uprooting and damage to the levee. A problem that levees pose is that floodwater trapped behind the levee cannot be easily be brought into the stream. Passage of auwai in and out must be accommodated. In this valley there is enough slope to set up sections of setback levees with openings. Pipes can be used through the levee.

Manowai are rock dams that direct water into the auwai. Manowai are constructed and maintained by hand labor. Manowai are appropriate technology because during high flows the rock dam is usually washed down and limits the amount of water directed to the auwai. Auwai can function as flood conveyance at flood stage. Many members of the Waipi'o community feel that all channels and conveyance channels need to be utilized during high flow in the valley.

Approaches for Stream Maintenance

There are three basic approaches to implementing the above alternatives: Hand Clearing, Minimal Mechanical Excavation and Heavy Equipment/Mechanical Excavation. A description of some of the positive and negative impacts of these approaches is included below.

Hand Clearing

Hand Clearing seeks to minimize the need for many of the permits and involves manually hand clearing the stream mouth. This requires a concerted effort involving volunteers or paid laborers drawn from the community. This proposal directly involves the community and in essence brings back to life an old cultural practice; however, it requires a significant number of reliable laborers or volunteers on a reliable basis. Compared to heavy equipment excavation, it is possible that hand clearing may not be sufficiently efficient.

Minimal Mechanical Excavation

A second proposal scales down the amount of material to be excavated. By mechanically excavating to a more shallow depth, the total material could be diminished. The environmental and cultural impacts would probably be halved in proportion to the excavation effort and sitting of the dump pile may be easier to locate. Although this proposal requires heavy equipment and would probably require permits, the preparation of the permit applications may not be as time consuming.

Heavy Equipment/Mechanical Excavation

The use of heavy equipment would enable a massive amount of material to be removed relatively quickly. Few laborers would be needed and the stream banks could be graded to scientific specifications. Best Management Practices could be utilized to lessen environmental damage. However, the permit process may require public hearings, review of documentation, field visits by several agencies and could take time to complete the study and obtain all permits.

The proposed stream mouth clearing will remove sand, cobbles, and boulders that prevent.

Pilot Project: Wailoa River Mouth Maintenance

The maintenance of an open river mouth is a high priority for many in the Waipi'o community. The blocked river mouth causes many problems that include the following issues:

- 1) increased flooding of taro lo'i in the lower part of the valley,*
- 2) increased auwai and lo'i water temperature due to slower outflow back into river,*
- 3) increased deposition of sediment and loss of stream capacity in the lower part of the valley and*
- 4) increased stream depths at the lower locations to cross the river.*

The intent is to allow free-flowing of the stream into the ocean. The intent is to excavate the outlet of the stream in the blocked reach to the elevation of mean high tide. Deeper excavation will not result in any further significant reduction in stream level. A major consideration is prevention of rapid redeposition of boulders and cobbles in the stream mouth. While the store of boulders and cobbles within the bay is virtually inexhaustible, preventing the newly- excavated

stony material on the beach from resettling into the river mouth can be prevented by disposing of the cobbles and boulders in areas away from the reach of high waves. In addition, removal of adjacent boulder sources along the beach will also reduce the chance of rapid blockage of the stream mouth.

The river mouth opening through mechanized means will require, at a minimum, the

Department of Army permit, the Commission on Water Resources' Stream Channel

Alteration Permit, and the Hawaii County Department of Planning's Special Management Area Permit exemption. Other requirements and permits include a Conservation District Use Application if the work extends beyond the certified shoreline and Solid Waste Disposal permit.

Budget:

A budget for the valley wide project has not yet been projected. The community will need to work with a FEMA representative to conduct a benefit-cost analysis (using the FEMA framework) if they are to qualify for the Hazard Mitigation Grant Program (HMGP) or the Pre-Disaster Mitigation Grant Program (PDM). The budget will need to price the work according to the mitigation measure. For instance, in some cases the plan calls for tree removal or topping. This action may be charged per linear foot along the stream. The past USDA NRCS Emergency Watershed Program work in Waipi'o may be a source for starting a comprehensive budget for the long-term, routine resilience program.

NRCS spent \$250,000 (in 2005 dollars) on retro-active work from 1979 storm. Ten years later they spent, \$170,000 on post-disaster recovery. Cost-savings for preventative measures should be reflected in the budget.

The proposal cost for the first stage: 3,300 cubic yards at \$12 per cubic yard = \$39,600.

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